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ABSTRACT

This study investigates the perceptual processing capabilities by analysis of eye movement of children from differing levels of field independence/dependence. Forty nine field independent (24 girls, 26 boys) and 36 field dependent (19 girls, 17 boys) children in third grade were analyzed as they viewed either seven dynamic or seven static segments from the Children's Television Workshop program. It was hypothesized that both good readers and field independents would exhibit more sophisticated scanning strategies and that the dynamic mode of presentation would result in significant eye movement differences from those exhibited in the static mode. Regression analyses revealed that eye movements were rather stimulus specific. Supplantation of mental operation by the stimuli was also an important consideration of this study. (Author/MP)

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Eye Movements, Individual Differences, and Television-Viewing Patterns of Children

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This particular study was designed to investigate differences in attention demonstrated by field independent and field dependent children as they viewed the reading program The Electric Company. It was felt, in doing the research, that eye movement analysis would lend insight into the perceptual processing capabilities of children with differing levels of field-independence-dependence. Not only has little been done investigating the eye movements characteristic of attentional processes within this cognitive style domain but also no previous attempt has been made to assess the effects of media-related variables as they may or may not influence attention. It is the latter question that led to another dimension of this investigation - i.e. examining the effect that the quality of movement may have on structuring a stimulus field for the viewer.

The interactionist approach, taking into account theories and variables of learning, the learner, production principles and variables, and the structure of the learning task seems to be the direction that research in educational television is now taking. Recent studies (Salomon & Snow, 1968; Snow and Salomon, 1968; Salomon, 1972; Salomon & Clark, 1977) in the field have stressed the value of investigating how elements of an instructional or stimulus presentation ought to be conceptualized in terms of their interaction with person-related variables. Anderson (1972) stated "... there should be a conscious attempt to link production techniques to specific roles they might play in aiding part-

icular types of learning with specific types of behavioral objectives" (p. 61). For the purposes of this study, one might add "for particular types of learners".

In his work describing the processes of the foveal and peripheral systems as they relate to perception, Neisser (Mackworth & Bruner, 1970) specifies the means by which an individual constructs a visual field. This process of 'analysis by synthesis' is very much dependent on the nature of both the individual and the functions of the field they are viewing. It has been demonstrated (Mackworth & Bruner, 1970; Mackworth & Morandi, 1967) that as the individual develops from one bound by a display to a more differentiated, 'thinking' being, that their eye movement fixations reflect to some extent this developmental shift in perceptual processing. Eye movement indices lend insight into the nature of scanning strategies characteristic of the most unsophisticated, fragmented searches to those strategies described as proficient, and analytical (Vurpillot, 1968).

Basically then, "perception is a selective process which enables one to distinguish signal from noise" (Mackworth & Morandi, p. 550). Doing so, the 'learned' eye attends to only those stimuli in a field that will supply the cognitive structure with essential information in order to make judgments and hypotheses. But what of individuals whose cognitive styles are such that screening of incoming information is not limited to only relevant details resulting in 'uneducated' searches of stimulus

displays? Can materials be so developed to assist them in attending to relevant aspects of a stimuli while ignoring those that do not supply necessary information?

How can the scanning strategies of field-independents and field-dependents be described in terms of eye movement indices and by so doing contribute to understanding possible differences in the perceptual processing of these individuals? Previous research (Mock, 1975; Badanes, 1974; Wolf, 1971; Gould & Dill, 1969; & Tinker, 1958) has demonstrated that eye movement data is indicative of the effect that certain stimulus variables and modes of presentation can have on attentional processes. How then does the composition of a stimulus display, in terms of the effect of motion on the screen, in fact aid those in need of restructuring a field by highlighting the salient and information-loaded cues? Finally, can eye movement behavior be attributed to individual and/or stimulus characteristics?

As one dimension of the research, the variable of field-independence-dependence was chosen as a person-related factor whose characteristics have rarely been described by means of eye movement research.

Originally defined by Witkin (1954, 1962, 1964 & 1977), the concept field-independence-dependence has been used to describe how individuals perceive stimulus arrays which require being able to pick out of context relevant information. Witkin used the terms 'field independence' and 'field dependence' to describe an individual's mode of perceiving parts

within a larger stimulus structure. Field independent personalities are those possessing "an ability to receive, organize, integrate, and interpret a relevant stimulus, and thus overcome the influence of an embedding context" (1962, p. 2). Field dependent individuals find it "difficult to overcome the influence of a surrounding field or to separate an item from its context" (1962, p. 2).

Field independent individuals exhibit a broader and more sophisticated level of cognitive ability that Witkin calls 'field articulation'. Field articulation involves both the ability to analyze and to structure the visual field, whereas field dependent individuals are at the mercy of the existing organization of a stimulus array by their inability to impose their cognitive structure upon it. Field independent persons prefer a more structured stimulus presentation. As Witkin points out, it is how the material is organized for individuals that determines whether optimal learning takes place. For field dependents this means ordering the stimulus figures. Eye movement indices are used in this study to describe whether a dynamic or moving stimulus actually aids field dependents in overcoming their perceptual disability by structuring the presentation for them.

Two studies are cited in the literature on the topic of eye movements and field-independence-dependence. Conklin, Muir & Boersma (1968) found significant differences between field independent and field dependent children on track length and information search when performing the picture completion task of the Weschler Intelligence Scale for children.

They describe field independent children as employing more analytic search patterns. In support of Witkin's findings, Boersma, Muir, Wilton & Barham's (1969) eye movement study revealed that field independents do indeed spend more time attending to areas of high information content.

Although there are no studies to date which have utilized eye movement instrumentation in assessing the looking behavior of field independent and field dependent persons in relation to television viewing, there appears to be no reason why individual differences in overt perceptual processing of these individuals cannot be described by this means. This study also investigates the extent to which mode of stimulus display helps or hinders the perceptual analysis of individual learners.

In the line of formative research, the eye movements of field independent and field dependent children were analyzed as they viewed either seven dynamic or seven static segments from the Children's Television Workshop program The Electric Company. Field research of this nature provides an interesting way of examining professionally-produced television segments as they affect a viewer's attention to particular visual elements on the screen. Research of this sort lends insight into the effects of instructional devices used to attract and maintain attention to a visual display. Such information is useful to producers and educators alike as they design programs to meet the specific needs of learners.

The independent variables of field-independence-dependence and mode of stimulus presentation (dynamic versus static) were examined as they contributed to five eye movement indices - orientation time to target words (ORIENT), percentage of fixations on target word (FIXATION), percentage of time on target (TIME), percentage of left-to-right movement (L → R), and average duration of fixation (AVERAGE). These eye movement measures have been used in past studies to provide information as to the nature of the interaction between an individual and a stimulus presentation. For the purposes of this research, they are used to describe the nature of individual differences in attention to target words on the screen and the effects of movement, or lack thereof, in the stimulus field.

It is hypothesized that due to their more proficient employment of perceptual processing strategies as demonstrated by their skill in tests of field-independence-dependence, that field independent subjects would exhibit faster orientation times, a larger percentage of fixations, time, and L → R scanning patterns on target plus shorter durations of fixations.

Based on past literature suggesting that movement on the screen is a potent cueing device that may in fact supplant mental operations, it is also hypothesized that the dynamic presentation would yield similar eye movement-related patterns as those described for field-independent individuals.

Method

The eye movement patterns of eighty-five subjects were monitored by means of a Polymetrics Eye Movement Recorder (Model V-1164-1) and recorded on a PDP-9 computer. The subjects included forty-two boys and forty-three girls in third grade. They were administered the Children's Embedded Figures Test (Witkin, Ottman, Raskin, and Karp, 1971) prior to having their eye movements examined. A mean split was used to divide the subjects into their respective groups resulting in forty-nine field independent subjects (24 girls, 25 boys) and thirty-six field dependent subjects (19 girls, 17 boys).

Subjects were randomly assigned to either a dynamic or static stimulus mode condition. Each stimulus presentation consisted of seven segments from The Electric Company. The static presentation was produced by 'freezing' the moving segments and utilizing the same voice track.

The raw eye movement data was reduced with respect to the location of the 'target' words and the called for eye movement measure. The resultant data was then analyzed using a regression procedure (Service, 1972).

Results

Regression analyses were calculated for each segment (referred to as ALL) as well as analyses averaged over all segments together (MODE-AVERAGE). Further analyses were also performed on data gathered in the

early seconds of a segment's exposure (INIT). Of interest here were those results related to the main effects of field-independence-dependence (CEFT) and presentation mode (PRES). The interaction (CEFT x PRES) was also examined.

Field dependent individuals oriented significantly faster to target words for ALL-MODE-AVERAGE data ($F = 4.74$; $p < .05$). This finding is opposite to that hypothesized. For individual segments no significant orientation time differences existed between field independent and field dependent subjects. Data for one segment resulted in significant differences in percentage of fixation time ($F = 4.07$; $p < .05$) thus supporting the hypothesis. As far as percentage of time on target and percentage of left-to-right fixations are concerned the data did not confirm the direction hypothesized. On the eye movement measure related to duration of fixation, the hypothesis was confirmed for data on one particular segment ($F = 4.46$; $p < .05$) and across all segments together ($F = 5.18$; $p < .05$).

Orientation times were equivalent in both the dynamic and static stimuli. One segment resulted in significant differences in percentage of fixation on target for both early (INIT) and total segment (ALL) data (ALL-$F = 4.47$; $p < .05$; INIT-$F = 6.34$; $p < .05$). Data averaged over all the segments did not reveal that the dynamic stimulus led to a larger percentage of fixations on target as hypothesized. Significant differences for time on target, albeit opposite to that hypothesized,

were found in one segment where the static stimulus yielded a larger percentage ($F = 8.65$; $p < .01$). Early data on one segment resulted in significant differences in directional attack in support of the hypothesis ($F = 19.61$; $p < .001$) while early data on another segment revealed larger duration of fixation in the static mode as hypothesized ($F = 6.35$; $p < .05$).

The interaction of field-independence-dependence and mode of presentation (CEFT x PRES) resulted in very few significant effects. The implications for these and the main effect findings are discussed in the following section. Percentage of time on target varied significantly with level of field-independence-dependence and mode of presentation for one particular segment ($F = 10.08$; $p < .01$). Average duration of fixation data resulted in a significant two-way interaction for another segment ($F = 5.54$; $p < .05$) and for MODE-AVERAGE data ($F = 3.80$; $p < .05$). In the former larger durations were exhibited for field independents viewing the dynamic stimulus and field dependents in the static condition while the opposite held true when data was averaged over all segments.

Discussion

It is indeed difficult to explain and infer from data that results in so few significant findings. However these results do have some implications for both educators and producers of instructional materials. At one level they are indicative of the attentional processes related to individuals possessing differing levels of ability to overcome embeddedness

in a stimulus field while at another level the results demonstrate the effect that motion as a cueing device may have on attracting and maintaining attention to relevant stimuli in a display.

It would appear that overall field independent individuals do not generally differ from field dependents in terms of the eye movement patterns utilized in this study. This may be due to the fact that the stimuli themselves may have not been complex or embedding enough thus enabling field dependent children to pick out the areas of relevant information on the screen. Such an interpretation may also account for the lack of significance allotted to the mode of presentation results. The dynamic stimuli were not essential to the structuring of the field. This may have been due to the fact that the stimulus displays themselves were not that overwhelming to begin with.

The results suggest that overall the targets were quite distinct from the background; so much so that field dependent children had no trouble in finding them quickly (ORIENT). Lack of significance may have been due to lack of stimulus complexity, 'purposeful' production resulting in mental supplantation (doubtful possibility however based on mode of presentation results), and simply lack of differences in the looking behavior of field-independents-dependents on these eye movement indices. Contrary to what was hypothesized, field dependent children oriented significantly faster to the target words when data across all segments was examined. These results lend further support to the possibility that overall the targets were quite distinct from the background giving

field dependent children no trouble in finding them.

Generally the results were rather segment specific. However the question still arises as to the degree to which person-related and stimulus-related factors peculiar to these segments may have contributed to the nature of the results found in this study. Further investigation is necessary.

The shorter duration of fixations involving field independent subjects (at least in one segment and MODE-AVERAGE data) seem to support a field independent sampling process. Such a finding suggests that, characteristic of their style of processing information, field independent individuals spend time comparing target with non target areas as they attempt to find meaning within the context of a stimulus.

The results involving mode of stimulus presentation (dynamic versus static) also appear to be rather stimulus specific. Again the possibility exists that the stimulus displays were not complex enough such that movement became an indispensable feature of the segments. Where significant findings do exist (e.g. in an animated segment involving letters moving in a left-to-right fashion the results ought to be examined and probed further to assess how they may interact effectively with persons possessing different cognitive approaches to a task. The strength of the auditory channel may have diminished differences between the dynamic and static presentations. The possibility that auditory supplantati n took place ought to be pursued in future research of this sort. It seems

likely that the auditory channel acted as strongly as cues as to where to look. The general lack of significant CEFT x PRES interactions in this particular study negates any evidence of visual supplantation having occurred. The variables seem to have acted quite independently of each other in terms of the attentional measures employed in this research.

It was hoped in doing this study that comparing dynamic versus static elements in the manner produced for this research would eliminate some of the pitfalls of comparing two or more distinct modes of stimulus presentations as had been done in the past. It was felt that such a study would lend insight into the elements or code of one medium, namely television. The results suggest that movement was not necessarily an aid to particular field-independent-dependent groups.

It appears from this study that the task and its inherent qualities were what made light of the cognitive style differences individuals possessed. Further study of these stimulus-specific elements is one direction for future research into the code or syntax of a particular medium (Olson, 1974).

Eye movements, as real-time indicators, can serve a useful function to both those interested in instructional design and individual differences. Knowing that qualities of a stimulus field may evoke certain eye movement responses in individuals, instructional packages cannot only be designed to take advantage of these attention-getting and maintaining devices, but can also be paced according to the perceptual style of individual

information processes. Application of theory into practice is not limited solely to the medium of television but can be applied to other methods of communication (including the teacher) that are available in the teaching-learning environment.

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